

### **Cerebral and cerebellar sensorimotor plasticity following motor imagery-based mental practice of a sequential movement**

Michael G. Lacourse, PhD; Jessica A. Turner, PhD;  
Elizabeth Randolph-Orr, BFA; Steven L. Schandler, PhD;  
Michael J. Cohen, PhD

**Purpose of the Work.** This study determined whether motor imagery-based mental practice produces changes in brain sensorimotor processes that are similar to those accompanying physical practice. **Subjects and Procedures.** Thirty-nine healthy subjects completed a sequential motor task before and after 1 week of mental practice (MP), physical practice (PP), or no practice (NP) of the task. We measured brain activation by using functional magnetic resonance imaging and motor behavior by counting the number and accuracy of sequences completed in 30 s. **Results.** PP produced greater improvements in motor behavior than MP and NP, while MP led to greater improvements than no PP. Accompanying changes in brain sensorimotor processes were similar in some regions of the brain, while others were different following PP and MP. PP increased striatal and decreased cerebellar activation, while MP increased cerebellar, premotor, and striatal activation. More extensive changes in striatal structures with PP indicate a bias toward modified procedural learning mechanisms, while changes in activation outside the sensorimotor regions of interest following MP indicate a bias toward modifying explicit learning mechanisms. **Relevance to the Veteran Population.** Motor recovery from central nervous system trauma such as spinal cord injury or stroke may involve the use of compensatory brain sensorimotor processes. While PP can effectively produce those changes, MP might be efficacious to preserve pretrauma cerebral sensorimotor processes or produce compensatory processes before and during physical rehabilitation.

*Michael G. Lacourse, PhD*

### **Donepezil as an adjuvant to constraint-induced therapy for upper-limb dysfunction after stroke:**

#### **An exploratory randomized clinical trial**

Stephen E. Nadeau, MD; Andrea L. Behrman, PhD;  
Sandra E. Davis, PT; Kimberly Reid, MS;  
Samuel S. Wu, PhD; Brenda S. Stidham, RN;  
Karen M. Helms, PharmD; Leslie J. Gonzalez Rothi, PhD

**Purpose of the Work.** Donepezil, a drug that increases acetylcholine in the brain, is known to be important in forming new memories and developing new skills. This study determined whether giving donepezil to patients undergoing vigorous therapy for arm and hand impairment caused by stroke would increase the impact of that therapy. **Subjects and Procedures.** Twenty subjects were randomized to receive daily donepezil 10 mg or an identical-looking placebo tablet throughout a 10-day 6 h/d course of constraint-induced therapy, an intensive and practically oriented therapy of the impaired arm and hand that involves restraining the normal arm. We used a number of tests to measure the results, including the Wolf Motor Function Test (WMFT) (a test of speed in performing a number of actions with the impaired hand) and the Motor Activity Log (a measure of the quantity and quality of daily use of the impaired arm and hand). **Results.** The results showed that donepezil produced a somewhat better outcome as measured by the WMFT but not as measured by any other test. **Relevance to the Veteran Population.** Rehabilitative treatments that will improve recovery of function after stroke are urgently needed. This study suggests that donepezil might improve the efficiency of vigorous motor rehabilitation therapies. This study was not large enough to prove this, but it does justify the conduct of a larger study.

*Stephen E. Nadeau, MD*

### **Heel-region properties of prosthetic feet and shoes**

Glenn K. Klute, PhD; Jocelyn S. Berge, MSE;  
Ava D. Segal, BAS

**Purpose of the Work.** Excessive impact forces arising from heel-ground contact during walking may be responsible for increased soft tissue damage to the residual limb of the lower-limb amputee. Prosthetic feet and footwear can attenuate these forces to varying degrees and provide

protection for the amputee. Our purpose was to quantify the structural properties and energy dissipation capacity of these components. **Subjects and Procedures.** Seven different prosthetic feet and three different shoes were subjected to pendulum impacts that simulated the initial heel contact that occurs when walking. Three impact velocities (0.2 m/s, 0.4 m/s, and 0.6 m/s) were used to explore the range of conditions that occurs in amputee gait. **Results.** The seven different prosthetic feet exhibited a wide range of properties. Dissipation of impact energy by prosthetic feet ranged from 34% to 53%. Donning a shoe substantially increased energy dissipation to 63%, 73%, and 82% for a walking, running, and orthopedic shoe, respectively. **Relevance to the Veteran Population.** Knowledge of energy dissipation capacity can aid in prosthetic foot and shoe selection to reduce the risk of residual-limb soft tissue damage.

*Glenn K. Klute, PhD*

### **Effects of shoe heel height on biologic rollover characteristics during walking**

Andrew H. Hansen, PhD; Dudley S. Childress, PhD

**Purpose of the Work.** Most nondisabled persons can switch between pairs of shoes that have different heel heights and walk without difficulty. However, persons using lower-limb prostheses must maintain the heel heights of their shoes near the same level after their initial fitting to avoid alignment issues. This study examines how shoes of different heel heights affect the rollover characteristics of the biologic foot and ankle complex. **Subjects and Procedures.** Ten nondisabled women participated in the study. Each participant walked with three pairs of shoes of varying heel heights and at three walking speeds for each pair of shoes. Rollover shapes of the ankle-foot-shoe systems were measured for each walking condition. The rollover shape is a direct measure of the effective rocker to which the ankle-foot-shoe system conforms between heel contact and heel contact of the opposite foot. **Results.** The participants in the study adapted to the different shoes to maintain similarly oriented (angled) rollover shapes. **Relevance to the Veteran Population.** The results provide an explanation of shoe heel height problems for persons who use lower-limb prostheses. Artificial feet generally replace the ankle joint with a passive system that cannot automatically adapt to changing shoe heel heights to maintain a similarly oriented rollover shape. The initial alignment of the prosthesis with a par-

ticular pair of shoes creates a heel height constraint for other shoes that might be used with the device without further manual adjustments of the alignment. The results of the study indicate that rollover shape may provide a design goal for future prostheses that can adapt to shoes of different heel heights automatically, i.e., without manual alignment adjustment.

*Andrew H. Hansen, PhD*

### **A systematic literature review of the effect of different prosthetic components on human functioning with a lower-limb prosthesis**

Harmen van der Linde, MD, PhD; Cheriell J. Hofstad, MsC;  
Alexander C. H. Geurts, MD, PhD;  
Klaas Postema, MD, PhD; Jan H. B. Geertzen, MD, PhD;  
Jacques van Limbeek, MD, PhD

**Purpose of the Work.** We performed a systematic literature review to obtain evidence-based information about the effects of different prosthetic components on human functioning with a lower-limb prosthesis. This should provide an objective starting point for further development of consensus-based criteria for prosthetic prescription in the Netherlands. Prosthetic prescription for patients with lower-limb amputation is primarily based on empirical knowledge. The development of scientifically based clinical guidelines is a way of making health care more consistent and efficient and diminishes the gap between what clinicians do and what scientific evidence supports. This review is restricted to clinically oriented studies. **Procedures.** We identified clinical studies addressing the effects of different prosthetic components on human functioning with a lower-limb prosthesis by systematically searching the Medline database, Current Contents, The Cochrane Database, and PsycLit. The quality of the studies was assessed with the use of predetermined methodological criteria. **Results.** Some evidence has shown that energy-storing feet result in a comfortable walking speed and stride length that are about 7% to 13% higher than with a conventional foot in both traumatic and vascular transtibial amputees. Possibly, such feet also facilitate the symmetry of gait. These considerations seem important particularly for the active prosthetic user. Less-active prosthetic users may benefit from an early foot-flat mechanism to facilitate weight transfer onto their prosthesis. With regard to the prosthetic knee, active prosthetic users may profit from the advanced characteristics of swing-phase controllers, whereas the elderly vascular

patients tend to profit more from the stance-phase stability that is provided by a conventional locked-knee unit. Despite a huge amount of literature, our formal clinical knowledge concerning the effects of different prosthetic components on human functioning with a lower-limb prosthesis has considerable gaps. Therefore, with regard to prosthetic guideline development, we must still greatly depend on clinical consensus among experts. **Relevance to the Veteran Population.** The subject of this review fits within one of the priority areas of the *JRRD*. A number of reviewed articles have previously been published in the *JRRD*.

*H. van der Linde, MD*

**Ambulatory activity in men with diabetes:  
Relationship between self-reported and real-world  
performance-based measures**

Douglas G. Smith, MD; Elizabeth Domholdt, PT, EdD;  
Kim L. Coleman, MS; Michael A. del Aguila, PhD;  
David A. Boone, CP, MPH

**Purpose of the Work.** The measurement of walking activity is important in many outcome studies, and often the physical activity scale of the Short Form-36 (SF-36) health assessment questionnaire is used as the sole measurement of walking activity. This study determines the relationship between the SF-36 questionnaire and the Step Activity Monitor, a real-world, performance-based tool that counts the actual number of steps taken during daily activities. **Subjects and Procedures.** The physical activity of 57 men with diabetes was studied with the use of step-count monitoring and the SF-36 questionnaire. **Results.** The subjects averaged 3,293 steps/d, but had a very wide range (111–11,654) and a large standard deviation (SD) ( $SD = 2037$ ). The correlations between total daily steps and the SF-36 Physical Component Summary score and the Physical Function, Bodily Pain, and Vitality scales of the SF-36 were only fair (Pearson  $r = 0.376, 0.488, 0.332, 0.380$ , respectively). **Relevance to the Veteran Population.** Veterans volunteer their time and energy to participate in many health-related quality of life research projects. This study shows that physical activity is a complex concept and that the correlation between actual walking activity and the SF-36 questionnaire is not as strong as many researchers believe. This finding could have major implications for some outcome studies on veterans that measure walking activity as a major outcome variable.

*Douglas G. Smith, MD*

**Interlimb symmetry of traumatic unilateral  
transtibial amputees wearing two different prosthetic  
feet in the early rehabilitation stage**

George N. S. Marinakis, PhD

**Purpose of the Work.** This study evaluated the SACH and the Greissinger Plus prosthetic feet for the interlimb symmetry they provide during gait, by indexes calculated with three different methods, of traumatic unilateral transtibial amputees in the early rehabilitation stage. **Subjects and Procedures.** Sagittal plane gait analysis was carried out for nine right-limb amputees wearing a patellar-tendon-bearing prosthesis with a soft removable liner. The mean time from amputation surgery was 38.9 weeks, and the mean time from limb fitting was 16.3 weeks. The independent variable used in this study was the type of prosthetic foot (i.e., the SACH foot and the Greissinger Plus foot). The dependent variables were spatial (hip, knee, and ankle joint range of motion [ROM]) and temporal (walking speed, cadence, and stance phase period) gait parameters and the correspondent symmetry indexes, calculated with three different methods. **Results.** In all examined cases, when the SACH foot was replaced by the Greissinger Plus foot, the spatial and temporal parameters measured were significantly improved. When the symmetry indexes were considered, significant improvement was observed for the hip and ankle ROMs and the stance phase period. No significant difference was found for the symmetry indexes of the knee ROM, cadence, and walking speed. In addition, for most spatial parameters the statistical significance varied considerably among the three methods used for the analysis of symmetry. **Relevance to the Veteran Population.** Both the SACH and Greissinger feet have been around for a long time and used by many amputees; the SACH foot historically has been the most common prosthetic foot used in the United States. Therefore, a comparison of their behavior in terms of the symmetry that each foot provides during gait in the early rehabilitation stage might be useful for clinicians, researchers, and U.S. veterans. In particular, the finding that the symmetry indexes of walking speed and cadence were not significantly improved when the SACH foot was replaced by the Greissinger Plus foot might be useful for clinicians and veterans. Clinicians and researchers may want to know that the three methods used to calculate the symmetry indexes gave varied results, which, in some cases, led to quite different conclusions.

*George N. S. Marinakis, PhD*

### **Quantification of prosthetic outcomes: Elastomeric gel liner with locking pin suspension versus polyethylene foam liner with neoprene sleeve suspension**

Kim L. Coleman, MS; David A. Boone, LCP, MPH;  
Linda S. Laing, BA; David E. Mathews, LCP;  
Douglas G. Smith, MD

**Purpose of the Work.** This study compared the influence of two socket liner/suspension systems for transtibial artificial legs on patient satisfaction, comfort, pain, and walking activity during normal daily life. The systems studied were the Alpha<sup>®</sup> Liner (a gel-type liner) with locking pin suspension versus the Pe-Lite<sup>™</sup> socket liner (a firm foam-type liner) with a neoprene knee sleeve for suspension. **Subjects and Procedures.** Thirteen people with amputation of one leg below the knee completed the study. Each subject was fitted with two new study limbs in random order and wore each limb for a minimum of 3 months. Subjects were encouraged to return to the laboratory whenever they needed adjustments or other prosthetic care. At the end of each condition, satisfaction, pain, and socket comfort were measured with questionnaires. Walking activity was measured with the StepWatch monitor, which was worn on the ankle. The StepWatch recorded the number of steps taken each minute for 2 continuous weeks. After wearing both limbs, subjects were asked to choose which they would prefer for continued wear. Throughout the study, the users' comments regarding each limb system were recorded. **Results.** On average, subjects took 83% more steps per day and wore the prosthesis an estimated 82% more time with the Pe-Lite system versus the Alpha system. During the time each limb was worn, however, activity intensity did not differ. This suggests that subjects undertook similar activities in each limb. No differences were found in satisfaction, pain, or socket comfort as measured by questionnaire responses. When asked to choose between the two study limbs, 10 people said they would prefer the Pe-Lite system for continued wear and 3 people preferred the Alpha system. Common issues mentioned as affecting preference included ease of getting the limb/socket on and off, amount of maintenance and hygiene required, security of prosthetic attachment to the body, comfort over short and/or long periods of time, and skin irritation, durability, and cosmetic considerations. **Relevance to the Veteran Population.** The prosthetic socket is probably the component most critical to comfort and function of a lower-limb prosthesis. Socket systems range greatly in cost, durability, and maintenance requirements. Little objective information from well-designed

scientific studies is available to help guide choice. This study provides objective information regarding socket systems from a study design that fairly tested each system. Patients may benefit by learning about others' experiences with socket systems. The data may provide useful reference for prosthetists when choosing the most appropriate system for each patient. This study may also assist the VA in policy decisions regarding prosthetic care.

*Kim L. Coleman, MS*

### **Reliability and validity of the Family Satisfaction Scale with survivors of traumatic brain injury**

Andrea T. Underhill, MS, MPH; Steven G. LoBello, PhD;  
Philip R. Fine, PhD, MSPH

**Purpose.** This research project investigated the internal consistency and convergent validity of the Family Satisfaction Scale (FSS) in survivors of traumatic brain injury (TBI). **Subjects and Procedures.** The FSS scores of 541 survivors of TBI were assessed at 12 months postinjury and 340 survivors of TBI were assessed at 60 months postinjury. Internal consistency was determined with the use of Coefficient Alpha (Cronbach's Alpha). Convergent validity was ascertained through correlations between FSS total score with Life Satisfaction Index-A (LSI-A) total scores, as well as correlations with variables related to marital status, living arrangement, and average number of family contacts outside the home. **Results.** The internal consistency of the FSS was 0.94 (12 months postinjury) and 0.95 (60 months postinjury). Significant mean differences in FSS total scores were found among the marital status groups (single, married, widowed, divorced/separated) at 12 months ( $F_{3, 534} = 6.04, p < 0.001$ ) and 60 months ( $F_{3, 335} = 4.52, p < 0.005$ ). There was a significant correlation between FSS total score and estimated number of family contacts outside the home ( $r_{342} = 0.12, p < 0.03$ ). Finally, there was a significant correlation between the LSI-A total scores and FSS total scores at the 60-month follow-up ( $r_{337} = 0.43, p < 0.001$ ). **Relevance to the Veteran Population.** This research deals with a patient population that has much in common with the U.S. service veteran. First, most of the participants were young men, similar in many ways to the younger military veteran who was retired from service because of serious injury. The veteran who is retired as a result of catastrophic injury has many personal adjustments to make, and his or her family has many adjustments to make as well. Because of this, the service member who is medically discharged from the mili-

tary because of catastrophic injury often must return from the hospital or rehabilitation unit to a family structure that has made significant changes to accommodate the needs of the survivor. When the injury leaves visible physical or behavioral stigmas, the family may be the only social group in which the survivor finds acceptance and support. For these reasons, any research into factors that affect family satisfaction would be relevant to the veteran population.

*Andrea T. Underhill, MS, MPH*

### **Perceived exertion and rehabilitation with arm crank in elderly patients after total hip arthroplasty: A preliminary study**

Celine Christine Grange, MS; Jerome Maire, PhD;  
Alain Gros Lambert, PhD; Nicolas Tordi, PhD;  
Benoit Dugue, PhD; Jean-Noel Pernin, PhD;  
Jean-Denis Rouillon, MD, PhD

**Purpose of the Work.** This study compared the effects of traditional rehabilitation with a 6-week arm-crank exercise rehabilitation training program on the physiological perceptual and functional responses in seven elderly osteoarthritis (OA) patients (mean age  $74.9 \pm 5.0$  years) immediately after total hip arthroplasty. **Subjects and Procedures.** A training group (TG) and a control group (CG) were compared. We conducted a maximal graded test before surgery to determine fitness level and again after the 6-week arm-crank exercise rehabilitation program for TG and after 6 weeks of traditional rehabilitation for CG. TG had three training sessions per week for 6 weeks, with interval training exercise periods of 30 min. The training consisted of a 30 min interval training session with six successive work bouts of 5 min each. During each work bout, a 4 min period of moderate exercise (base level) was followed by a 1 min period of intense exercise (peak level). At each training session, heart rate (HR) and perceived exertion (PE) were recorded. After the program, each group performed a 6 min walk test. **Results.** At the beginning of the training program, HR/PE were not significantly correlated in all patients. However, at the end of the training program, five patients had a significant HR/PE relationship ( $p < 0.05$ ). Furthermore, positive effects of the arm-crank exercise rehabilitation program were observed on the cardioventilatory and functional responses, compared to the CG. **Relevance to the Veteran Population.** These results suggest that a 6-week arm-crank training program increases the fitness level and

functional efficiency of the OA elderly after total hip arthroplasty. Furthermore, after a habituation period, most elderly OA patients recovered their body sensations, and PE could be used in these patients to regulate exercise intensity during a rehabilitation training program. After 70 years, 10% of people have clinical signs of hip OA [American Academy of Orthopaedic Surgeons, Mazière B, Cantagral A, Laroche M, Constantin A. Generality about arthrosis. Practical guideline about arthrosis. Paris: MMI; 2000. p. 433–65.]. Little is known about the factors that cause OA, but it is probable that mechanic factors (e.g., strenuous physical activities or intense physical exercise) are a major activating factor. Then patients become more and more sedentary, leading to a physically deconditioned state. This program and the use of PE to self-regulate exercise intensity after a habituation period could help veterans develop training or rehabilitation programs at home to decrease their sedentary lifestyles and increase their fitness levels.

*Celine Christine Grange, MS*

### **Is the Human Activity Profile a useful measure in people with knee osteoarthritis?**

Kim L. Bennell, PhD; Rana S. Hinman, PhD;  
Kay M. Crossley, PhD; Ben R. Metcalf, BS;  
Rachelle Buchbinder, MS; Sally Green, PhD;  
Geoffrey McColl, PhD

**Purpose of the Work.** The Human Activity Profile (HAP) is a questionnaire designed to measure physical activity levels. This study determined if the HAP is a useful measure for people with knee joint osteoarthritis (OA). **Subjects.** Participating in the study were 226 men and women over the age of 50 years with painful knee OA. Also involved were 33 men and women of a similar age without knee OA. **Results.** This study found that the HAP is a reliable and sensitive questionnaire for the measurement of physical activity in people with knee OA, more so in women than men. **Relevance to the Veteran Population.** Knee OA is a common problem, affecting one-third of people aged over 60 years. Even though physical activity is essential for health and well-being, physical activity levels are rarely measured in knee OA. People with knee OA are less active than healthy people of a similar age, which may have negative consequences for their overall health status.

*Kim L. Bennell, PhD*

**Conservative methods for reducing lateral translation postures of the head: A nonrandomized clinical control trial**

Deed E. Harrison, DC; Rene Cailliet, MD;  
Joseph Betz, BS, DC; Jason W. Haas, DC;  
Donald D. Harrison, PhD, DC, MSE;  
Tadeusz J. Janik, PhD; Burt Holland, PhD

**Purpose of the Work.** This study was the first to show improvements in lateral translation postures (side shift) of the head with conservative methods. **Subjects and Procedures.** Fifty-one patients with chronic neck pain and lateral translation posture (side shift) were studied while they received a new type of inpatient rehabilitation, termed “mirror-image methods”, which include opposite postural exercises and opposite postural traction. The treatment subjects were compared to a control group of

26 subjects with lateral head translation posture and chronic neck pain. Radiographic measurements and pain scales were compared at initial and follow-up sessions for treatment subjects (at 12 weeks) and control subjects (at 50 weeks). **Results.** While no statistically significant changes were observed for control subjects’ pain and radiographic measurements, treatment subjects showed improvement in radiographic measurements of head translation posture and pain. **Relevance to the Veteran Population.** These findings aid researchers studying new treatments for persons with chronic neck pain and abnormal side shift head posture, including veterans. Improvement in these subjects will encourage future conservative care utilizing these promising new mirror-image exercise and traction treatments.

*Deed E. Harrison, DC*